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ABSTRACT

College students may be influenced by a variety of factors when choosing a major. Mathematics anxiety has received substantial attention, but has not been considered as a factor in choice of college major. The relationship between mathematics anxiety and the academic majors chosen by new freshmen prior to enrollment was investigated for a group of 423 male and 573 female entering students. Subjects completed the Content-Specific Anxiety Scale to measure their mathematics anxiety level. Their chosen majors were also rated for mathematics content over a standard four-year curricula. Students choosing lower mathematics-content majors had significantly higher mathematics anxiety scores than those choosing high mathematics-content majors. Females had significantly higher scores than did males on mathematics anxiety. Findings suggest that mathematics anxiety may be a substantial factor in choice of academic major. (Author/NRB)

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Escape From Mathematics Anxiety as a Factor in Major Choice

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Running Head: Mathematics Anxiety

Escape from Mathematics Anxiety as a Factor in Major Choice

Selection of an academic major can be a difficult experience for many new college students. Studies of undecidedness, uncertainty, and tentativeness in academic major choice (Titley & Vattano, 1972, 1976), have indicated that major choice difficulties may be reflective of on-going developmental processes in the student. Difficulties in choosing a college major should be considered a normal and typical phenomenon among college students that is influenced by the variety of factors that make up the student's environmental press.

A review by Lenning, et al, (1974) has cited numerous studies of college student relating non-intellective factors to vocational-educational performance. There have also been many studies relating personality variables to vocational choice, (i.e. Rosenberg, 1962; Gripka, 1972; Appel and Witzke, 1972), none of which focus on a relationship to major choice. A number of non-intellective variables seem to account for some of the variance in achievement and vocational choice. However, no one variable has been shown to be a significant predictor.

Hawkins (1976) found that a variety of affect measures (general anxiety, decision anxiety, major-choice anxiety, vocational choice anxiety) as measured by the Concept-Specific Anxiety Scale (Cole & Oetting, 1968), could successfully predict educational-vocational decidedness. He concluded that dealing with negative affects should be part of the counseling process with undecided students.

Mathematics anxiety as a non-intellective factor in learning and achievement has received substantial attention over the past decade (Ernest, 1976), but has not been considered as factor in major choice.

This study investigates the relationship between mathematics anxiety and the academic majors chosen by new freshmen prior to enrollment and class attendance at a medium-sized western University (19,000 students), and differences in mathematics anxiety by sex.

Method

A random sample of 1,200 newly admitted freshmen students, or 50% of the 2,400 who planned to attend a summer orientation program, were requested to complete a questionnaire sent and returned through the mail prior to the orientation program. Of the 1,200 questionnaires sent, 996 (83%) were returned in usable form. Usable instruments were received from 573 (5 7.9%) females and 423 (42.5%) males. Seventy-two(93%) of the possible 78 undergraduate majors were represented in the obtained data. Representation of the number of students in each major who participated in the study closely approximated the percentages of freshmen actually enrolled in each major.

The Concept-Specific Anxiety Scale (CAS) by Cole & Oetting (1968) was used to measure mathematics anxiety. The concept used was "How I feel when I am taking a course that involves solving mathematical problems and taking mathematics examinations." The Concept-Specific Anxiety Scale measures anxiety toward specific concepts or stimuli, and is based on Speilberger's (1966) state-trait conception of anxiety (p. 16-19), which indicates that state anxiety is anxiety elicited by specific situations. Previous research (Cole, et al., 1969; Dinges & Oetting, 1972; Hall & Hinkle, 1972), indicates that the CAS had adequate validity for research purposes and high reliability ($r = .86$).

For the purpose of this study, sex of subject and major choice were defined as independent variables. Major choice was the undergraduate major chosen by the subject during the winter or spring prior to class

attendance in the fall. The rated amount of mathematics required by a given major (major choice mathematics content level) is labeled MMC level. Scores on the CAS were defined as the dependent variable and labeled as mathematics content (MA). Because of its bipolar format, the CAS provides scores that are indicative of low, neutral and high anxiety levels. CAS scores are classified for the purpose of this study by the authors of the CAS as follows:

Average CAS Item Score	Classification
1.00 - 2.00	low
2.51 - 3.99	moderately low
4.00 - 5.49	moderately high
5.50 - 7.00	high

The "high" score range is indicated by the CAS authors to be suggestive of "interfering" levels of anxiety. That is, an MA mean item score of 5.50 or higher would suggest that the individual would experience difficulty in performing in mathematics.

A panel of five trained professional advisers rated the amount of mathematics content required for each undergraduate major over the standard four-year curriculum on a five-point (non-high) scale. The panel members were provided with a listing of the mathematics course requirements in each major, but were not informed of the purpose of the study prior to their ratings. Ratings of this group were averaged and each major was classified on a four-point scale for mathematics content. Interrater reliability was .92.

Results

The results of statistical analyses are reported in the following order: 1) results of a two-factor ANOVA to determine a) differences in MA by MMC level, b) differences in MA by sex, and c) interaction effects of sex with MMC level for MA; and 2) results of Scheffe's post-hoc test to determine different MMC subgroups. ANOVA assumptions are met.

Also presented are tables showing the ten highest and ten lowest mean scoring majors for MA, and tables comparing percentages of students with high and low MA who are in high and low mathematics content majors.

Results of the two-factor ANOVA presented in Table 1 indicate a) significant differences in MA by MMC level--$F(3,993)=39.598$, ($p<.001$), b) significantly higher MA for females--$F(1,993)=9.118$, ($p<.003$), and c) no significance of interaction for sex with MMC level. Students in higher mathematics content majors had significantly lower mathematics anxiety than those in lower mathematics content majors and vice versa. Also, women demonstrated significantly higher mathematics anxiety than males, but sex and MMC level were not found to interact as a factor influencing MA. Sex and MMC level are noted as two separate factors operating on mathematics anxiety.

Insert Tables 1 and 2 about here

To further investigate the difference in MA, the data were subjected to Scheffe's test in order to make all possible pairwise

comparisons between the means of the four MMC levels. Results indicate that the MA means for three of the four MMC levels were significantly different from each other (p .05). MMC levels 1 and 2 (low and moderately low) were not found to have mean MA that was significantly different, but groups 1 and 2 were found to have mean MA scores that were significantly different from groups 3 (moderately high) and 4 (high). Finally, groups 3 and 4 had mean MA scores that were significantly different from each other.

Results of the two-factor ANOVA and Scheffe's test demonstrated significant differences in MA by MMC level suggesting an inverse relationship between mathematics anxiety and the mathematics content of majors chosen as detailed in Table 2.

Table 1

ANOVA Summary Table for Mathematics Anxiety by MMC Levels, Sex, and Sex-MMC Level Interaction

Source of Variation	df	Mean Square	F	P≤
Main Effects	4	5389.528	45.116	.001
MMC level	3	4730.317	39.598	.001
Sex	1	1089.209	9.118	.003
2-Way Interaction				
MMC level by sex	3	241.913	2.205	.109

Table 2

Mean Mathematics Anxiety Item Scores by Major Choice

Mathematics Content & Level by Sex

		Males		Females		Males & Females	
		N	$\bar{X}$ Item Score	N	$\bar{X}$ Item Score	N	$\bar{X}$ Item Score
Major Choice Mathematics Content Level	1	63	4.31	198	4.90	261	4.76
	2	44	3.98	139	4.51	183	4.39
	3	174	3.85	190	4.04	364	3.95
	4	142	3.13	46	3.07	188	3.12
		423	3.69	573	4.38	996	4.09

Scheffe's test for all possible pairwise comparisons between MMCL groups found three subgroups (1,2) (3) (4) significantly different from each other ($P<.05$).

Discussion and Conclusions

Results and analyses indicate that those who chose majors high in mathematics content had lower mathematics anxiety than those who chose majors low in mathematics content. It appears that mathematics anxiety may be a previously overlooked but important factor in determining the majors that students choose. Avoidance of anxiety may be just as important as interest factors in determining academic and perhaps vocational choice. Although major choice and vocational choice are not directly equated, major choice may be a reflection of vocational choice. Avoidance of high mathematics content areas of study may result in avoidance of certain occupations related to or requiring mathematical training.

The results also indicate that those students with lower mathematics anxieties are less likely to avoid choosing high mathematics content majors than those with high mathematics anxiety. Those with lower mathematics anxiety may make up a higher percentage of the workers in occupations requiring mathematical skills and training. Possibly, lower levels of mathematics anxiety may be an inclusionary factor in these cases.

A small percentage (3.2%) of students with high mathematics anxiety had chosen high mathmatics content majors. These students may have made inappropriate major choices influenced by one or a combination of parents, peers, job market conditions, or the media. These students, perhaps, had high general levels of anxiety and did not necessarily make an inappropriate major choice.

Since mathematics anxiety was generally high ($\bar{X}$ item scored = 4.09) in this study, it is further speculated that perhaps there was a developmental factor operating in the learning of mathematics. Anxiety generally results from aversive, punishing experiences. In the case of mathematics, perhaps criticism from teachers and realization of an inability to achieve up to expectation contribute to mathematics anxiety in those individuals at a developmental stage prior to that at which they are ready to use specific mathematical operations at the level being taught. Conversely, those at an appropriate developmental stage may have success experiences with mathematics that do not result in mathematics anxiety.

Interfering degrees of mathematics anxiety may make mathematics an aversive subject which becomes more mysterious and less understood with age. Increased mathematics anxiety may in turn close off an individual's options for education and careers. While attempts are being made to increase the understanding of science and the role it plays in the world such an achievement appears difficult in the face of what may be a somewhat pandemic mathematics aversion by the lay public.

Results of the ANOVA also showed that females had significantly higher mathematics anxiety than males. One should not infer that females are intrinsically more mathematics anxious than males. Rather, it is more likely that women are more mathematics anxious as the result of socio-cultural conditioning. No research was found to indicate that women have less innate mathematics ability than men. It is not surprising to note that only 4.5% of those employed as professional academic

mathematicians are female (Ernest, 1976), in view of the subtle educational and family influences which contribute to mathematics anxiety.

Women have not been encouraged to excel in mathematics and the lack of female role models at all levels has the effect of maintaining the idea that mathematics is "unfeminine". The erosion of these conditioning factors might result in the reduction of the differences in mathematics anxiety between the sexes. If women experiences less mathematics anxiety, they might be less likely to close off their options in mathematics and the sciences, and be able to provide a greater number of female role models, pursue careers requiring mathematics background, and promote acceptance of mathematics as the domain of both men and women. It would also be helpful if parents and teachers encouraged the study of mathematics in both men and women in a competent, non-punishing, and non-sexist manner.

It is important to note that there are a number of interventions available (systematic desensitization, modified anxiety management training mathematics anxiety. Such treatments might be helpful to encourage participation in mathematics course work if the anxiety is identified in a timely manner.

In conclusion, mathematics anxiety and resultant avoidance of mathematics may be strong factors in choice of major. It is also believed that mathematics anxiety is an obstacle to many men and women who could benefit from identification and management of mathematics anxiety in a way that would enable them to perform better, pursue training in and possible vocations related to mathematics.

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